Categorizing Nanomaterials

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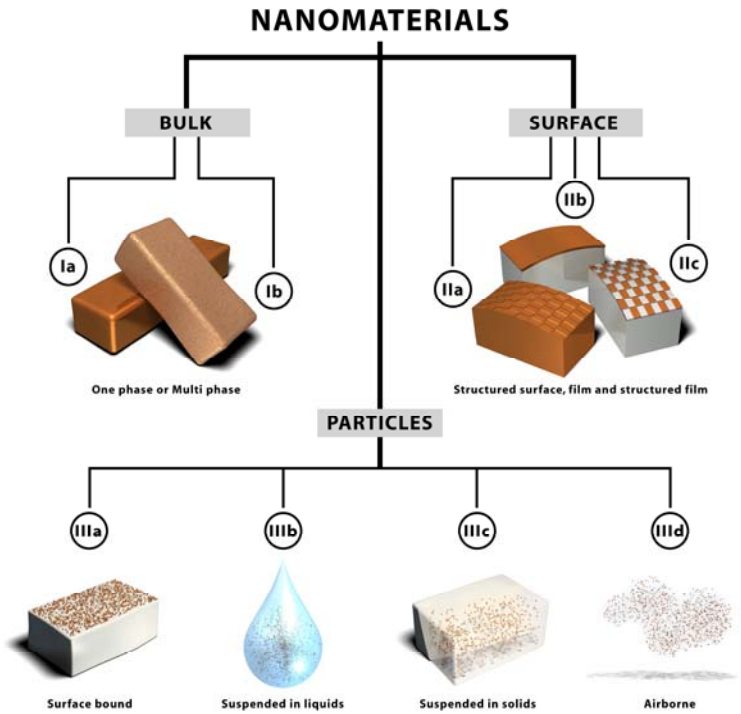
Categorizing Nanomaterials



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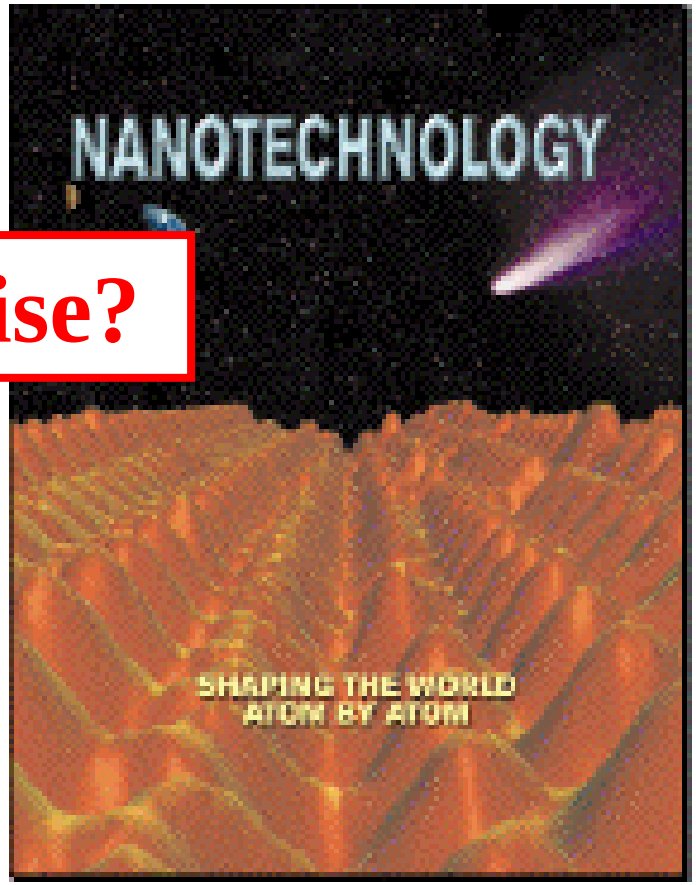
Department of Environmental Engineering

Nanomaterials – more than just NPs

- Lots of diff. nanomaterials
  - C_{60}, CNTs, QD, nanometals
  - Nan
    – st
- Lots of diff. technologies
  - Nano –manufacturing, electronics, photonics, catalysis, etc.
- Lots of diff. applications
  - ICT, biomedical, env. + energy, miltary tech., etc.

How to Categorise?

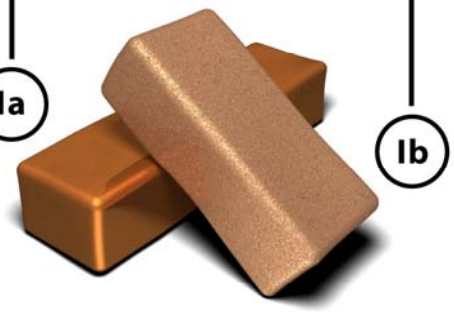


NANOMATERIALS

BULK

Ia

Ib



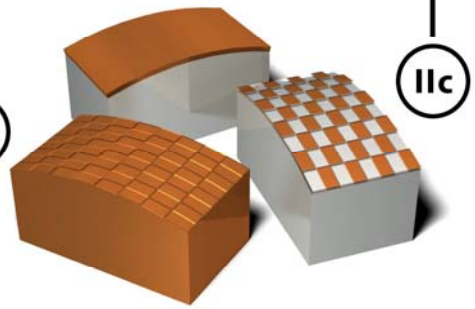
One phase or Multi phase

SURFACE

IIa

IIb

IIc



Structured surface, film and structured film

PARTICLES

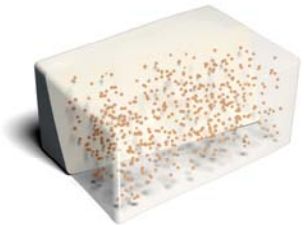
IIIa

Surface bound

IIIb

Suspended in liquids

IIIc



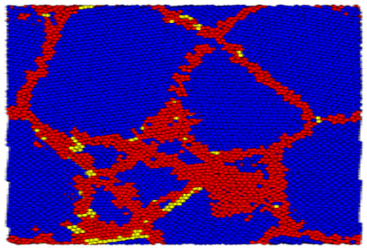
Suspended in solids

IIId

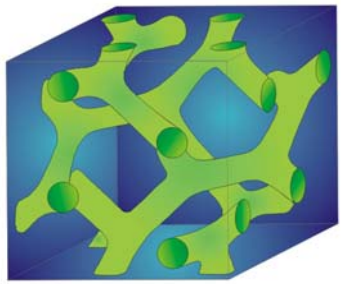
Airborne

Bulk

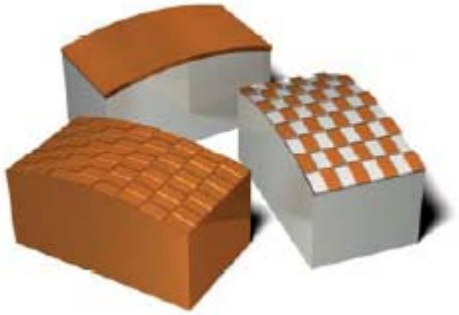
- One phase
  - Nanocrystalline copper



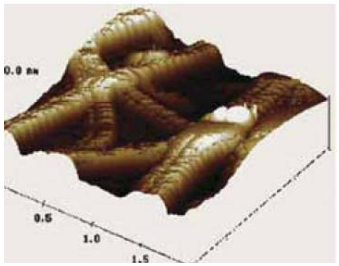
- Multiphase
  - Ceramic zeolites (porous)
  - Diblock copolymers (non-porous)



Surface

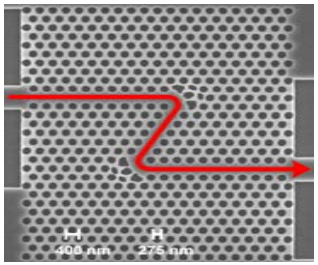


- **Structured on the nanoscale – same material**

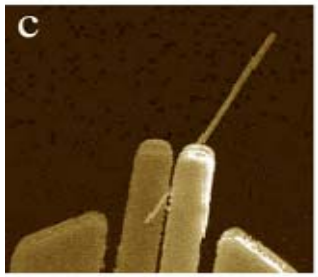


- **Nanoscale thick, un-patterned film**

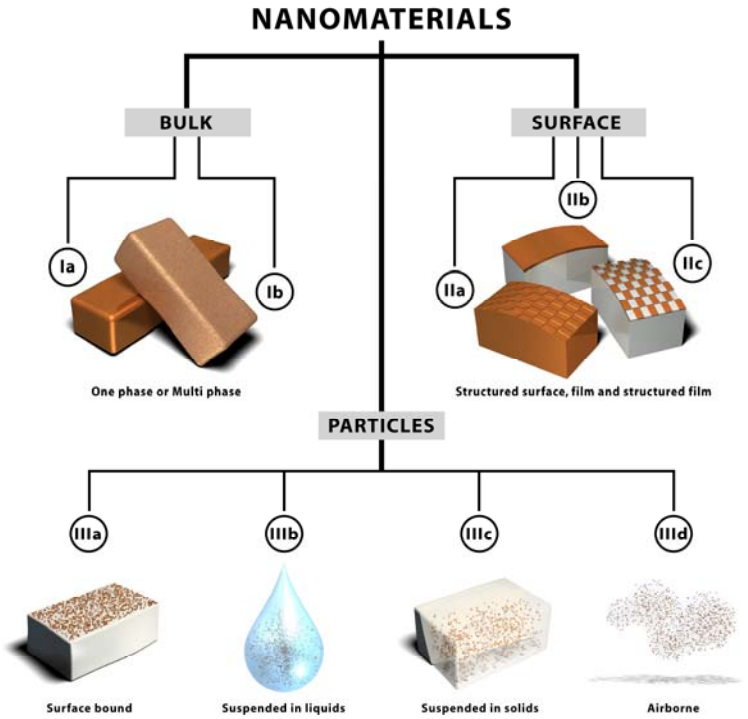
- **Patterned film –**
  - **film nanoscale in thickness**
  - **Surface pattern having nanoscale dimensions**



Particles



Workability



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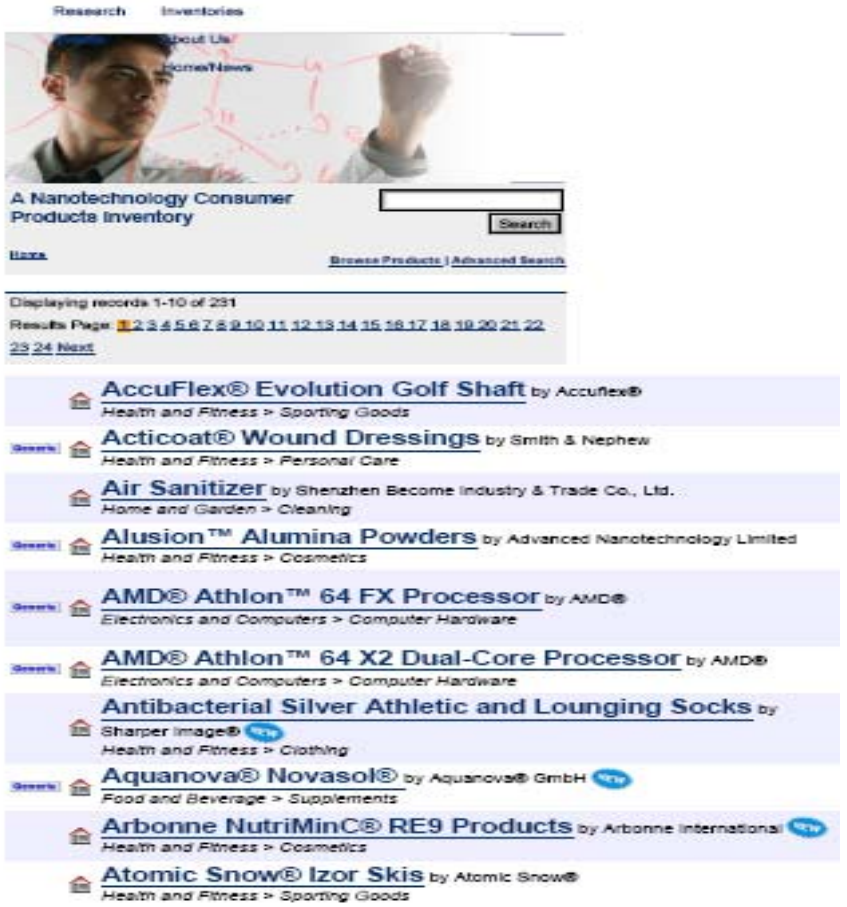
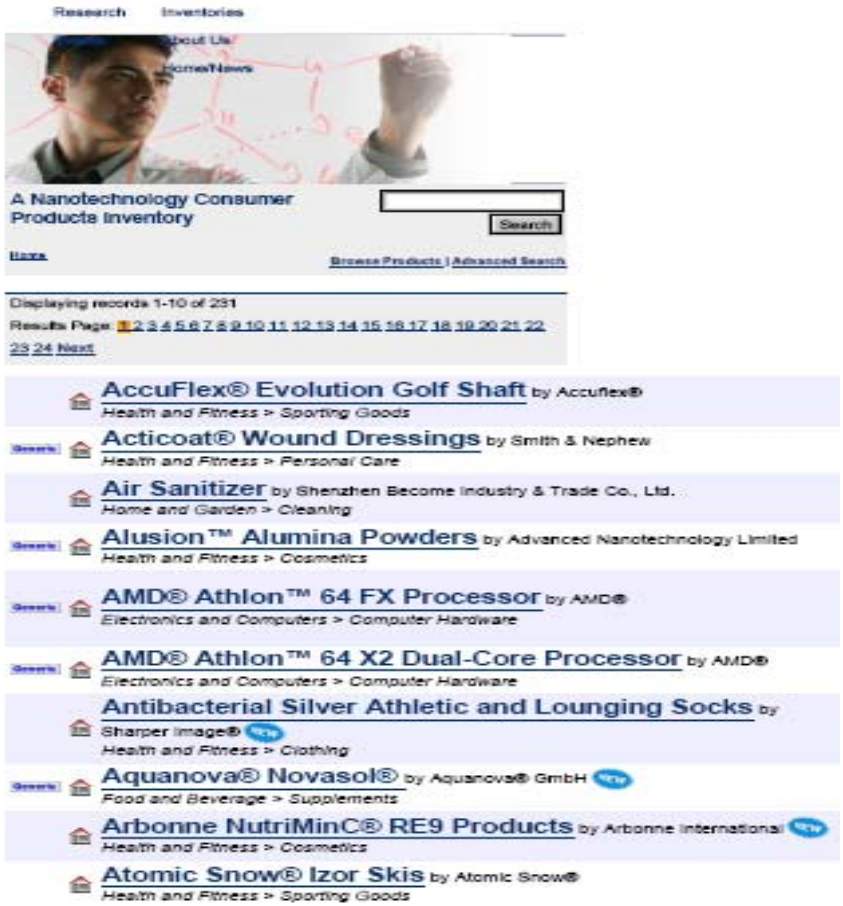


http://www.nanotechproject.org/index.php?id=44&action=view

W. Wilson Center Product Inventory

- **580 products**
  - Product name, Company, manufacturer or supplier, Country of origin, Product description
- **Limitations**
  - Only products advertised online
  - Based on reporting from manufacturers
  - Language barrier



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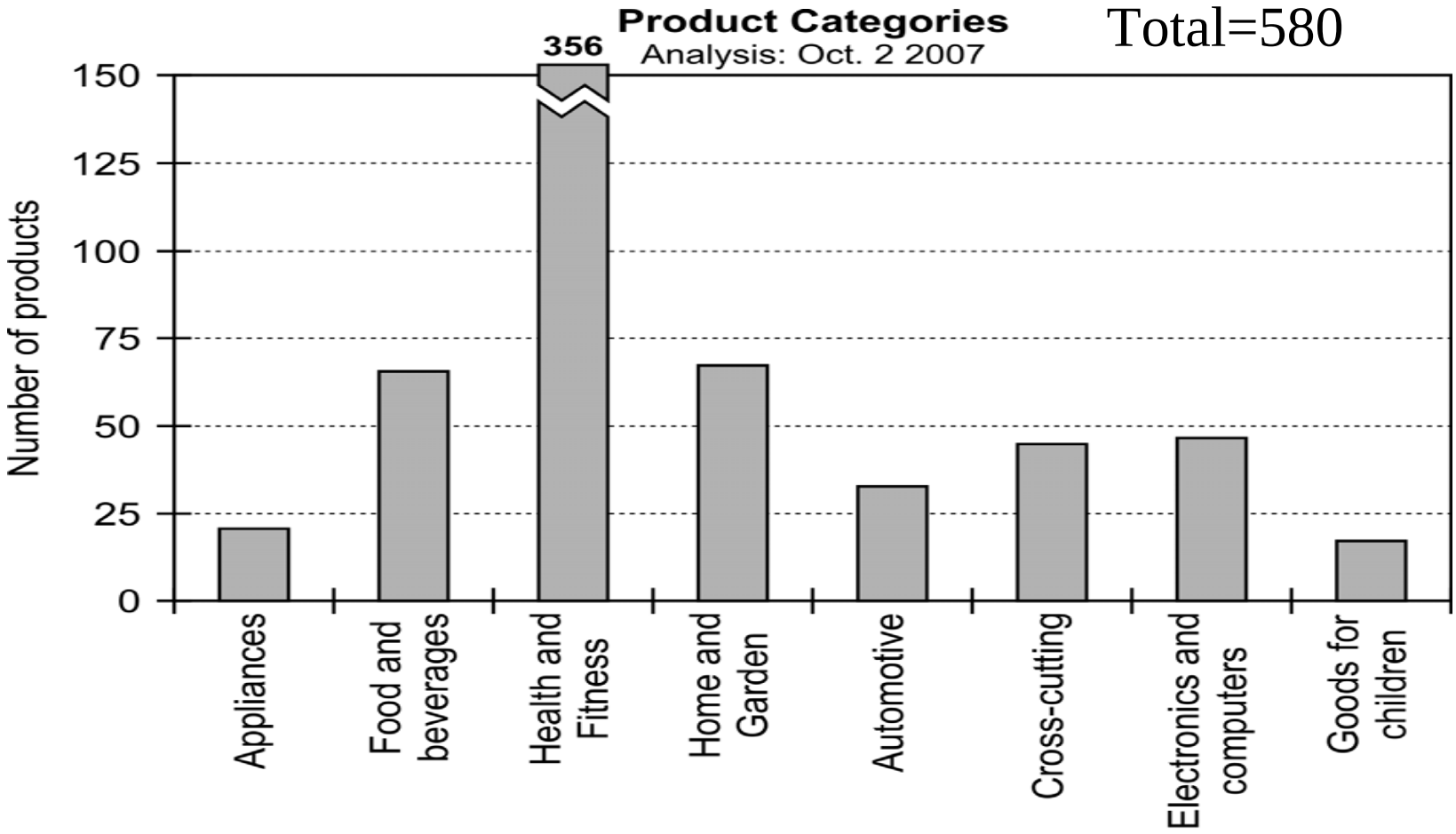
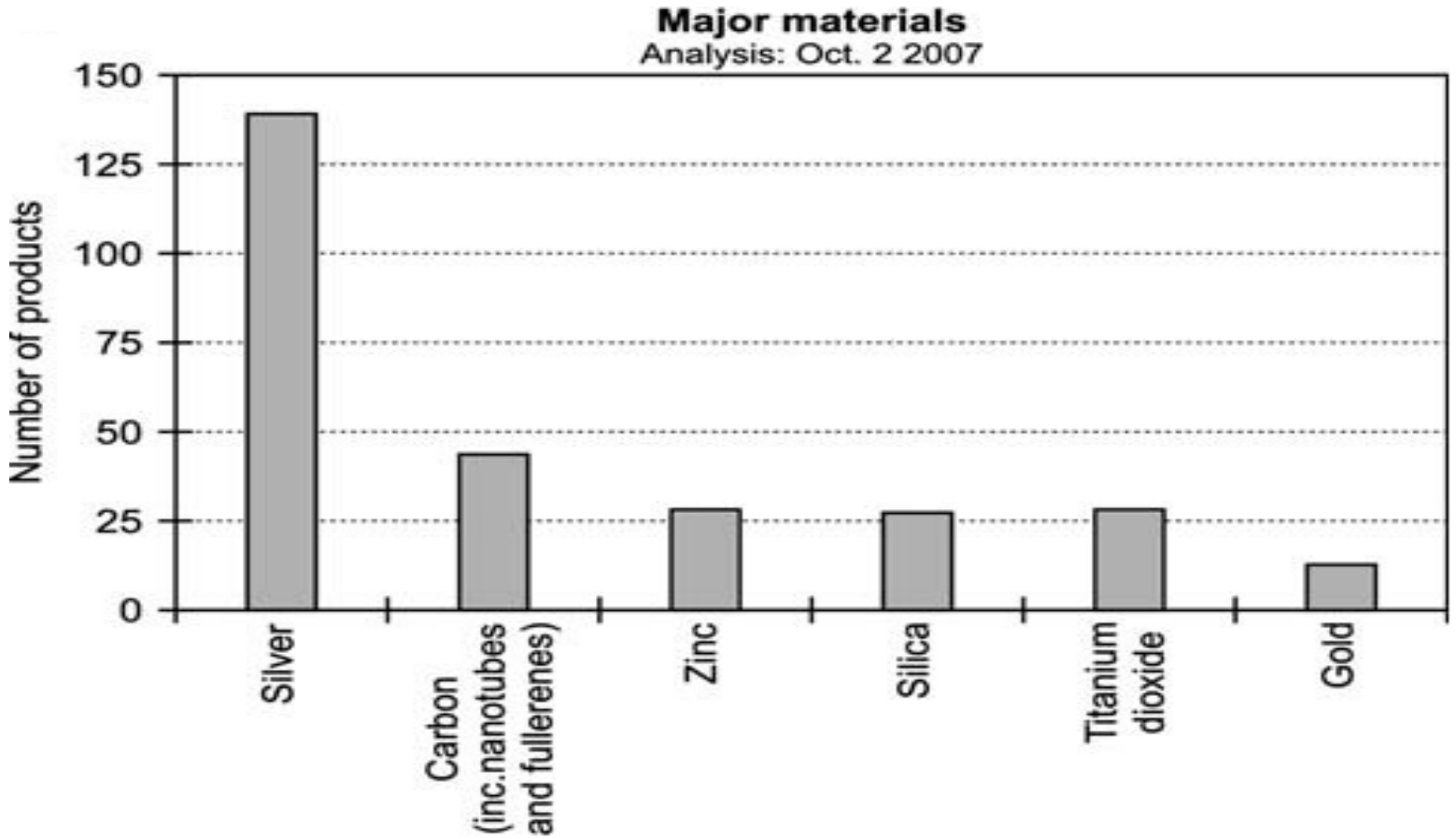
W. Wilson Center Product Inventory

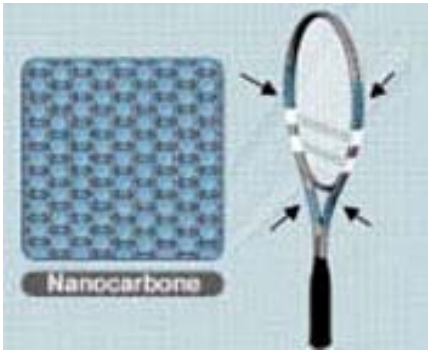


W. Wilson Center Product Inventory



Categorization: Example 1

- **Product: Babolat NS**
  Drive Tennis Racket



- **What they say:**

“Carbon nanotubes are used to shiffen key areas of the raquet”

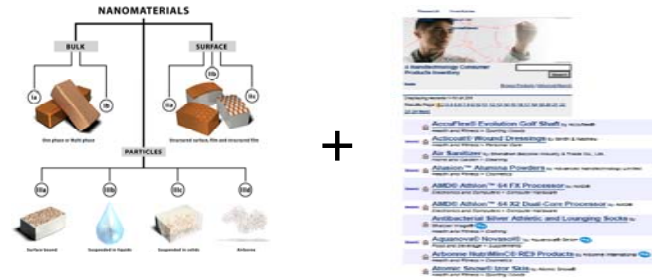
- **Our conclusion: CNTs Suspended in solids (IIIc)**

Categorization: Example 2

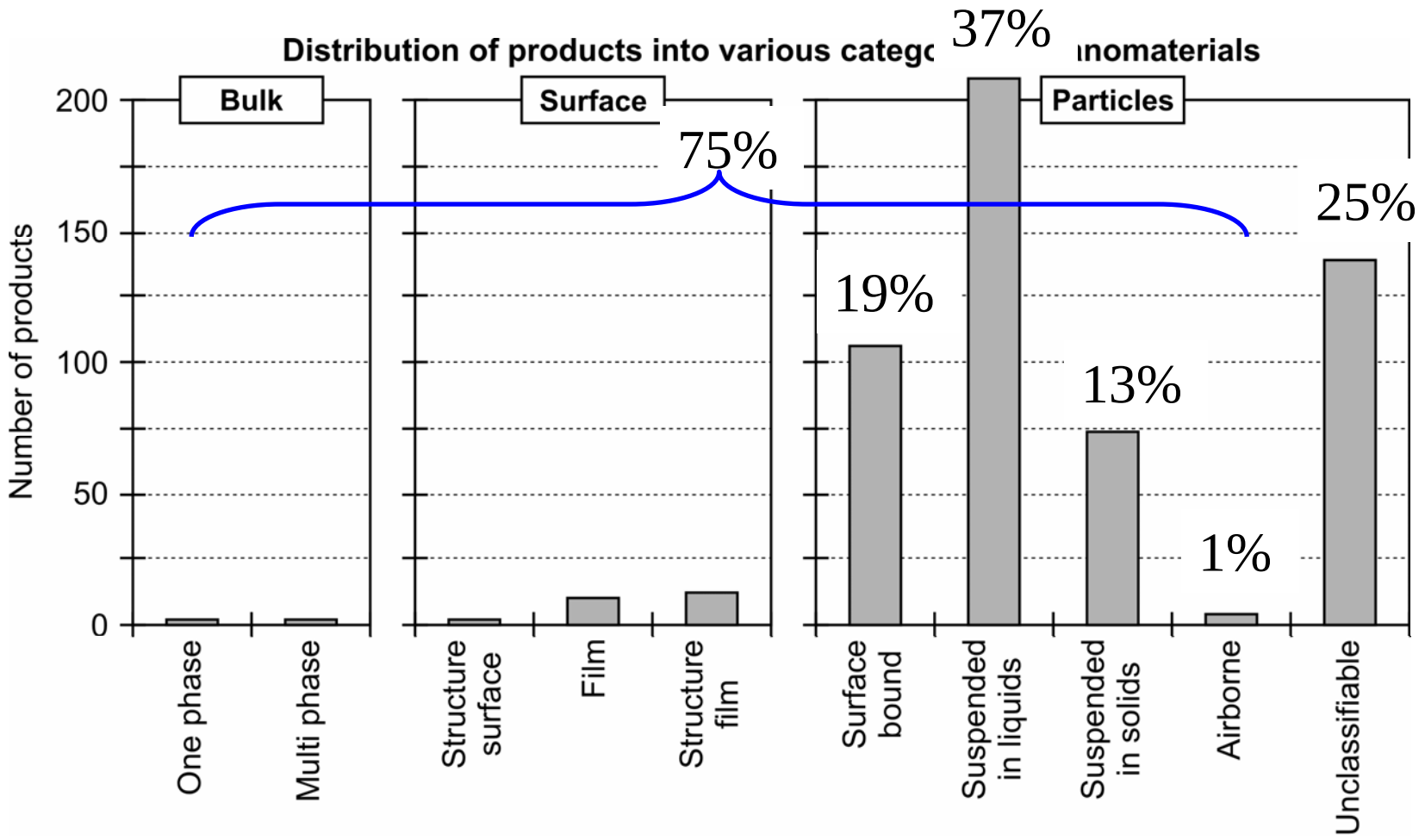
- **Product: Nano-in Deep Cleaning for make-up removal**
- **What they say:**
  - **“Superior nano ZnO formula combined with state-of-the-art nano micelle technology to completely remove makeup and dead cells, leaving your skin clean, smooth, and fresh.”**
- **Our conclusion: Nano ZnO Suspended in liquds (IIIb)**

Using the framework

Product	Argument	Category
AccuFlex Evloution Golf Shaft	"…Nano Composite technology enhancement increases the surface area of the shaft thereby creating a tighter molecular structure".	Suspended in solids (IIIc)
Acticoat Wound Dressings	"…The silver coated HDPE layers are designed to be barriers against microbial penetration".	Surface bound (IIIa)
Air Sanitizer	"Nano silver photocatalyst keeps the features of common air sanitizer."	Airborne (IIId)
Alusion™ Alumina Powders	"Alusion™ is a platelet grade of alumina powders specifically designed to provide soft focus properties with superior cosmetic feel"	Suspended in liquids (IIIb)
AMD Athlon 64 FX Processor	"…These tiny proportions allow AMD to etch onto a silicon die complex circuits of millions upon millions of transistors, which allow for more-powerful-but-smaller processors"	Structured surface (IIa)
AMD Atholn 64 X2 Dual-Core Processor	"…These tiny proportions allow AMD to etch onto a silicon die complex circuits of millions upon millions of transistors, which allow for more-powerful-but-smaller processors"	Structured surface (IIa)
Antibacterial Silver Athletic and Lounging Socks	"Cushioned, fitted, quarter-length sports socks knitted with a cotton material containing millions of invisible silver nanoparticles."	Surface bound (IIIa) ???
Aquanova Novasol	"The 100% watersoluble micelle can be integrated directly and independently of recipe characteristics into final products in the quoted fields."	Suspended in liquids (IIIb)
Arbonne NutriMinC RE9 Products	"Nanospheres: Infused with free radical fighting antioxidant vitamins, penetrate deep into the skin to protect, condition and adjust to skin's specific needs."	Suspended in liquids (IIIb)


NANOMATERIALS
BULK
SURFACE
PARTICLES

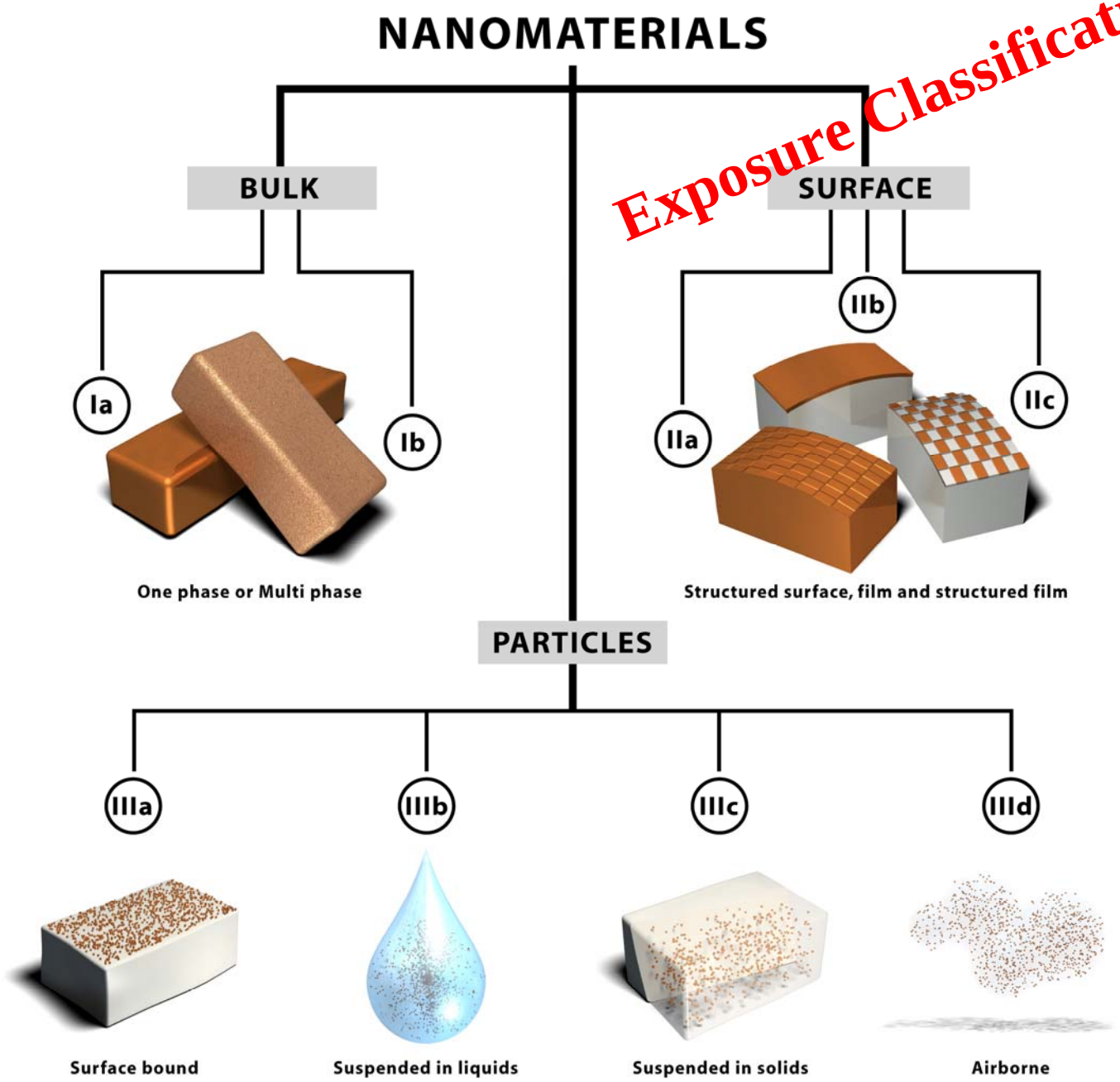
+


Distribution of products into various categ
nomaterials
Bulk
Surface
Particles
75%
37%
25%
19%
13%
1%
Number of products
200
150
100
50
0
One phase
Multi phase
Structure surface
Film
Structure film
Surface bound
Suspended in liquids
Suspended in solids
Airborne
Unclassifiable

Unclassifiable Products

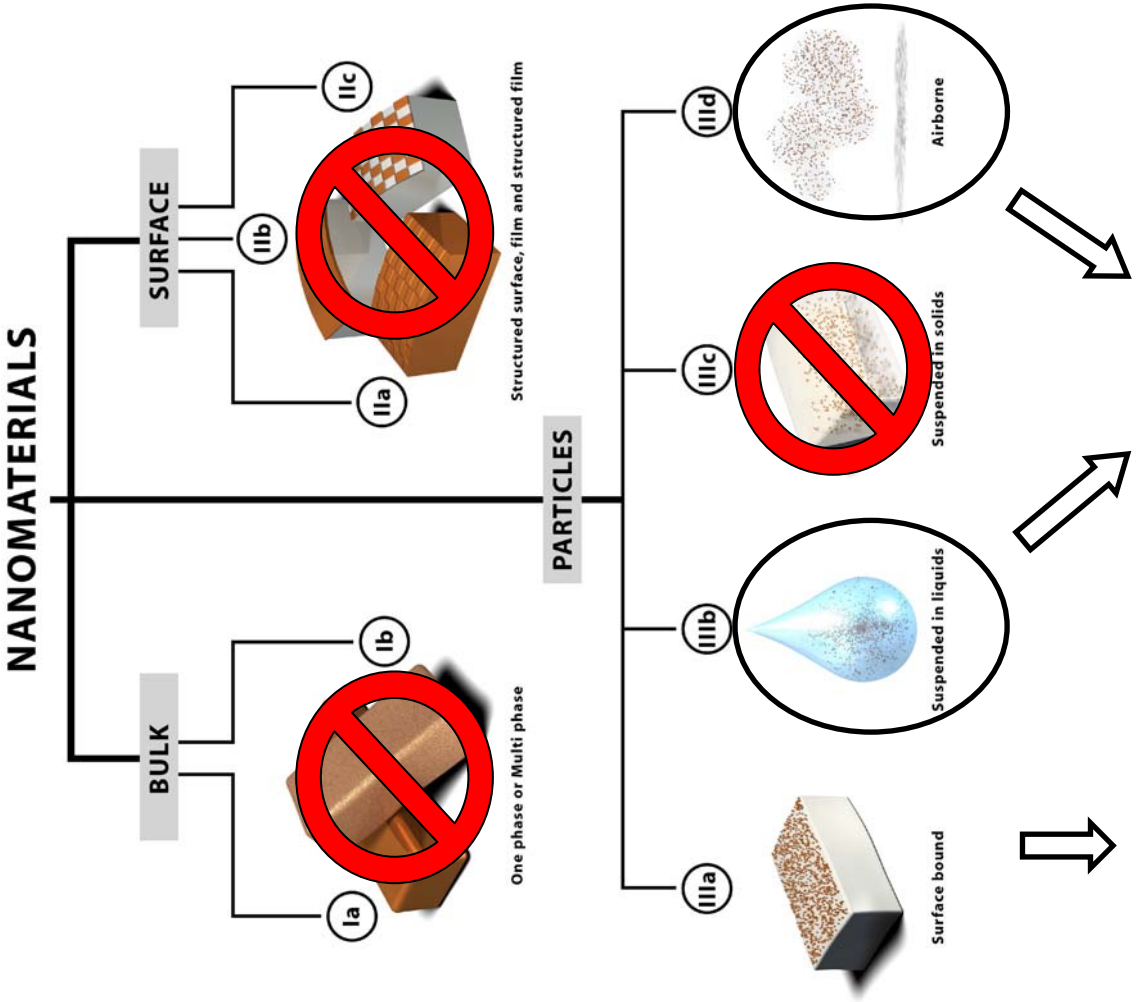
- **Product: Double L® Chinos**
- **What they say:**
  - **“Innovative Nano-Care® by Nano-Tex® treatment offers permanent stain and wrinkle resistance without changing the feel of the cotton.”**
- **No information on whats ”nano” or location**

Exposure Classification



Hansen et al., 2007. Nanotoxicology 1:243-250

Exposure Categories

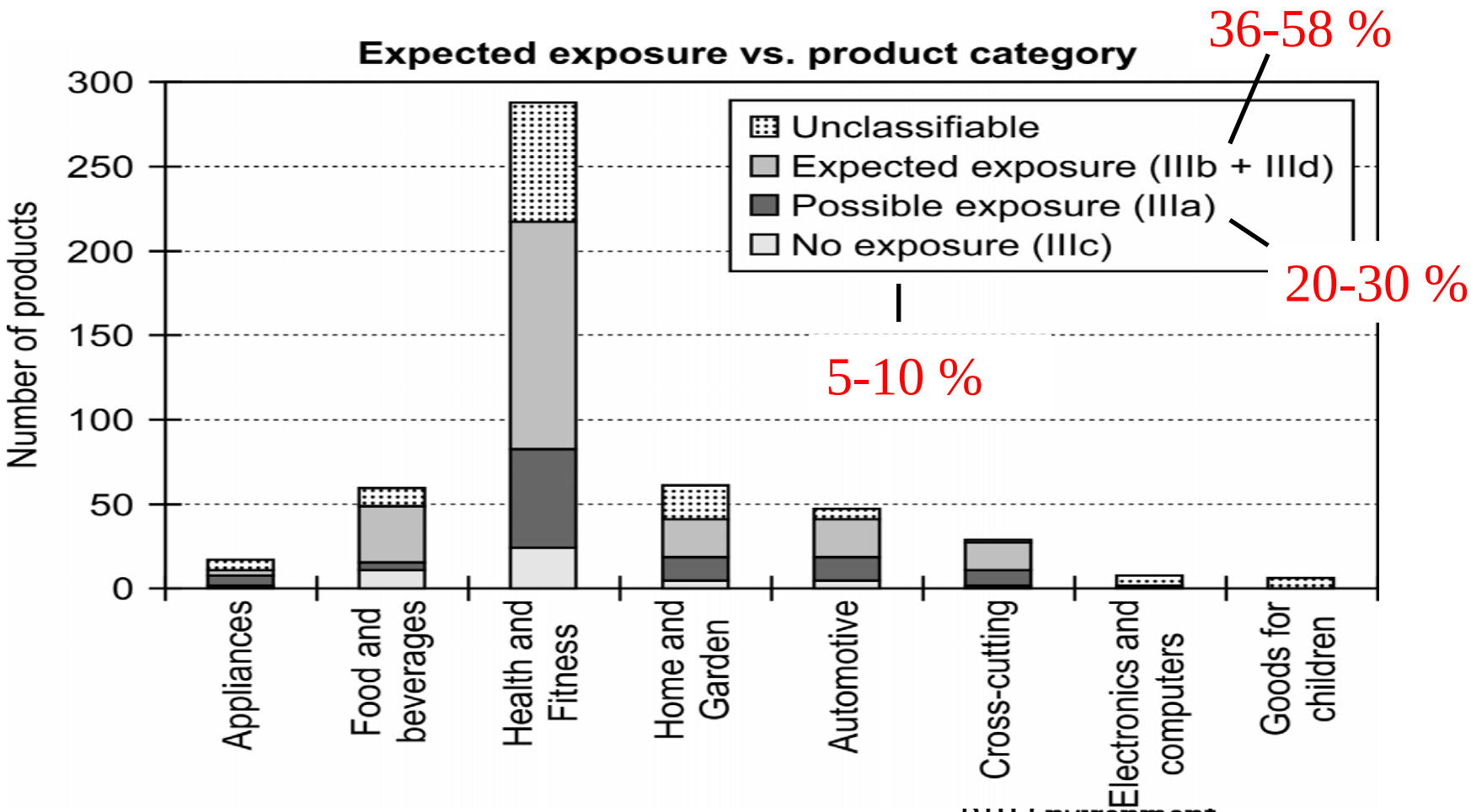


Expected exposure

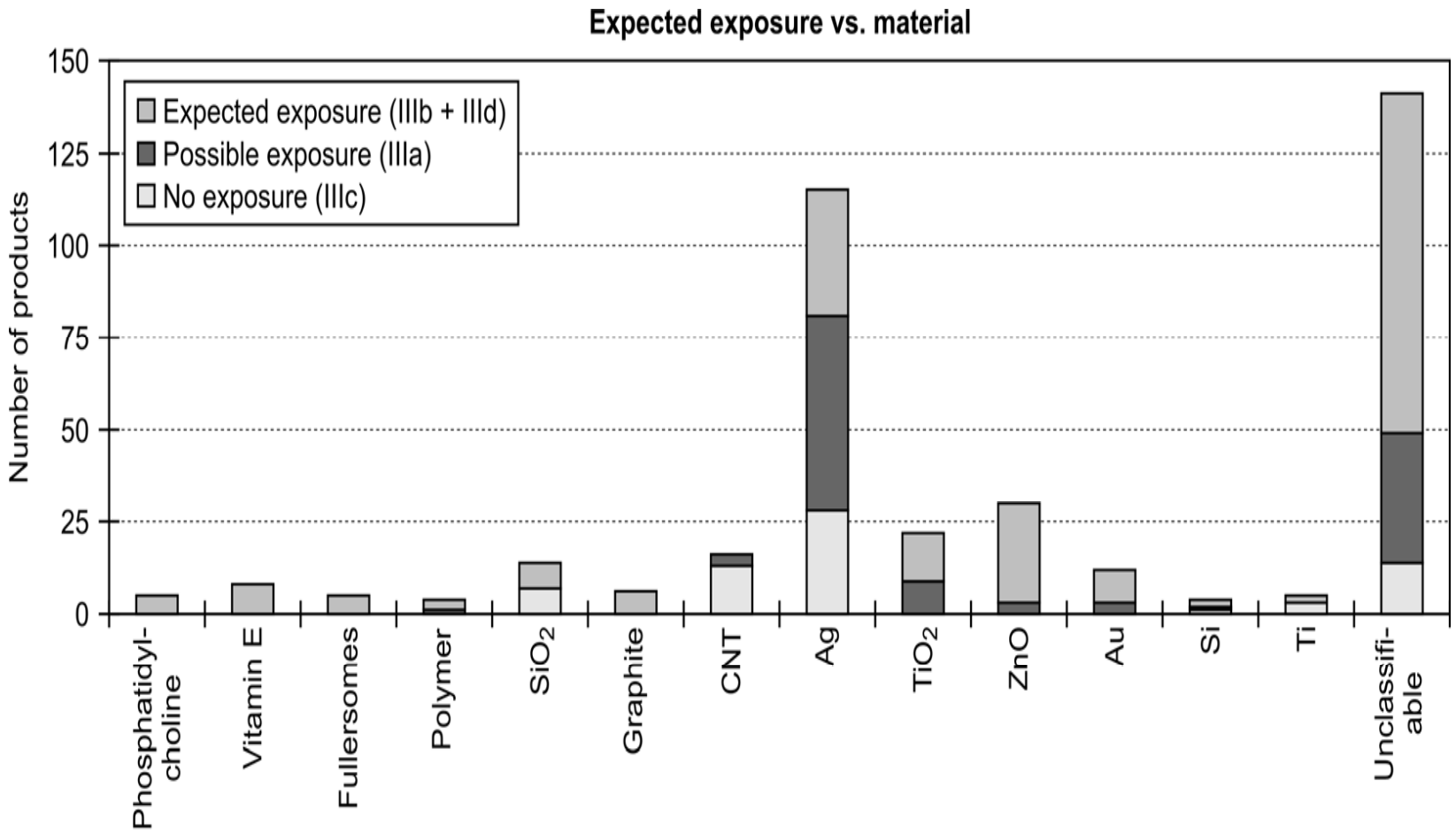
Possible exposure

Hansen et al. 2008. Ecotox 17 (5): 438-447.

W. Wilson Center Product Inventory



W. Wilson Center Product Inventory



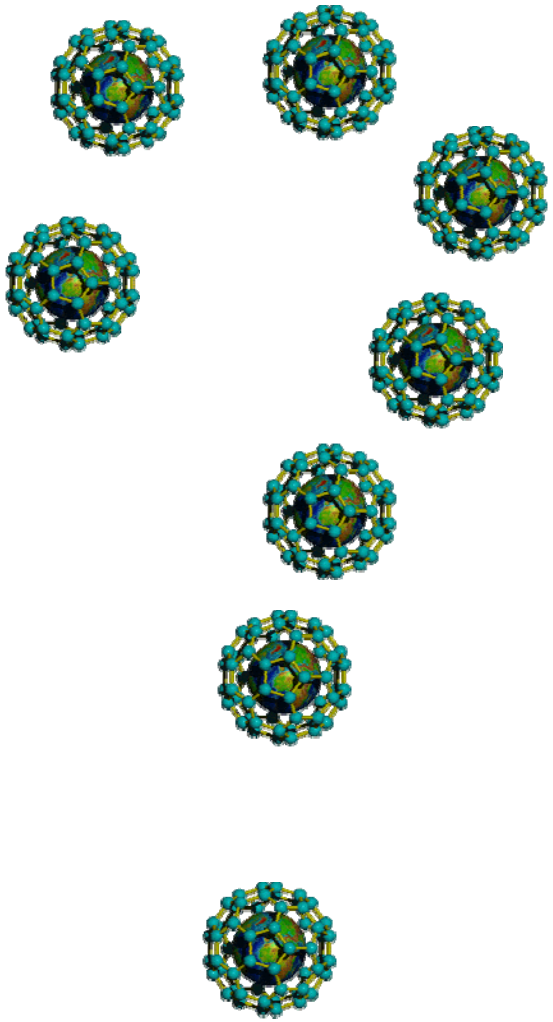
Conclusion

- Able to categorize 75% of 580 products
- Mainly NPs ”suspended in liquids” (37%) and ”surface bound” (19%) – Airborne = 1%
- Expected exposure to NPs = 45 %
- No exposure < 10 %
- Ag is predominant; exposure potential is high
- Unknown material used = Expected exposure high

Further information

- Hansen, S.F., Larsen, B.H., Olsen, S.I., Baun, A. 2007. Categorization framework to aid Hazard Identification of Nanomaterials. Nanotoxicology 1: 243-250.

- Hansen, S.F., Michelson, E., Kamper, A., Borling, P., Stuer-Lauridsen, F. & Baun, A. 2008, Categorization framework to aid exposure assessment of nanomaterials in consumer products. Ecotoxicology, 17 (5): 438-447.



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